

WBS 1.3

IST Overview

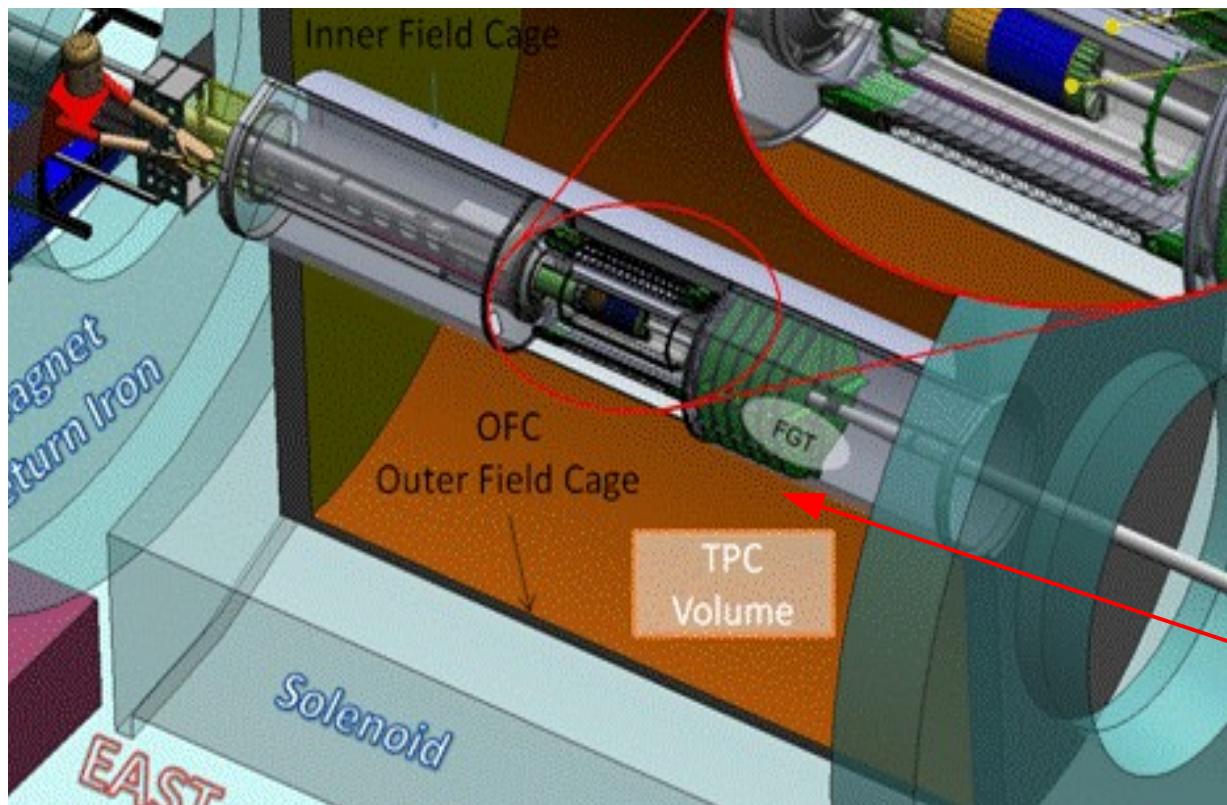
Gerrit van Nieuwenhuizen
MIT

IST presentation overview



- Detector overview
- Deliverables
- Technical description and design status
- Fabrication and testing
- Human resources
- Milestones and risk assessment

IST in HFT



TPC – Time Projection Chamber
(main tracking detector in STAR)

HFT – Heavy Flavor Tracker

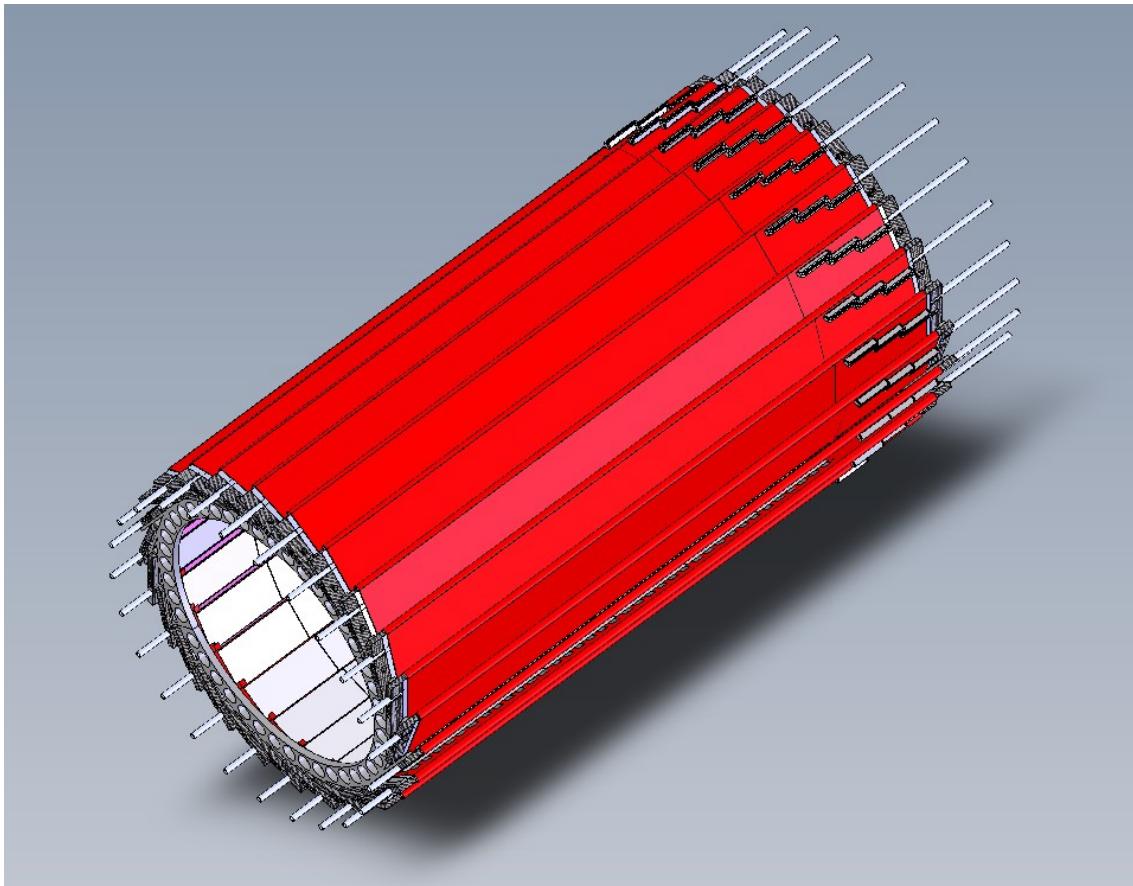
- **SSD** – Silicon Strip Detector
 - $r = 22\text{ cm}$
- **IST** – Intermediate Silicon Tracker
 - $r = 14\text{ cm}$
- **PXL** – Pixel Detector
 - $r = 2.5, 8\text{ cm}$

FGT – Forward GEM Tracker
Shares almost identical
readout system with IST

We track inward from the TPC with graded resolution:



IST overview



Radius	14cm
Length	50cm
ϕ -Coverage	2π
$ \eta $ -Coverage	≤ 1.2
Number of ladders	24
Number of hybrids	24
Number of sensors	144
Number of readout chips	864
Number of channels	110592
R- ϕ resolution	172 μ m
Z resolution	1811 μ m
Z pad size	6000 μ m
R- ϕ pad size	600 μ m

IST has entered production phase

IST deliverables



- 27 (24+3 spares) staves with six sensors per stave
- 24 IST staves installed on the Middle Support Cylinder
- Silicon bias voltage system for 24 staves
- Readout system for 24 staves
- Cabling and Cooling Services

Delivered by March-April 2013

IST stave



IST prototype stave

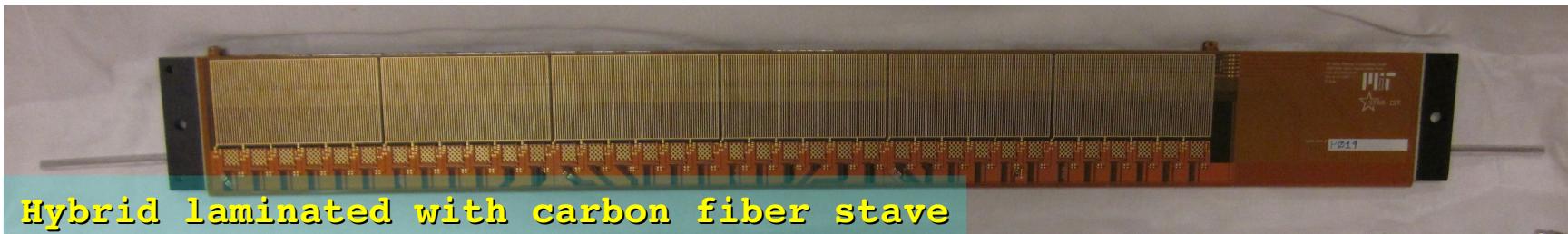
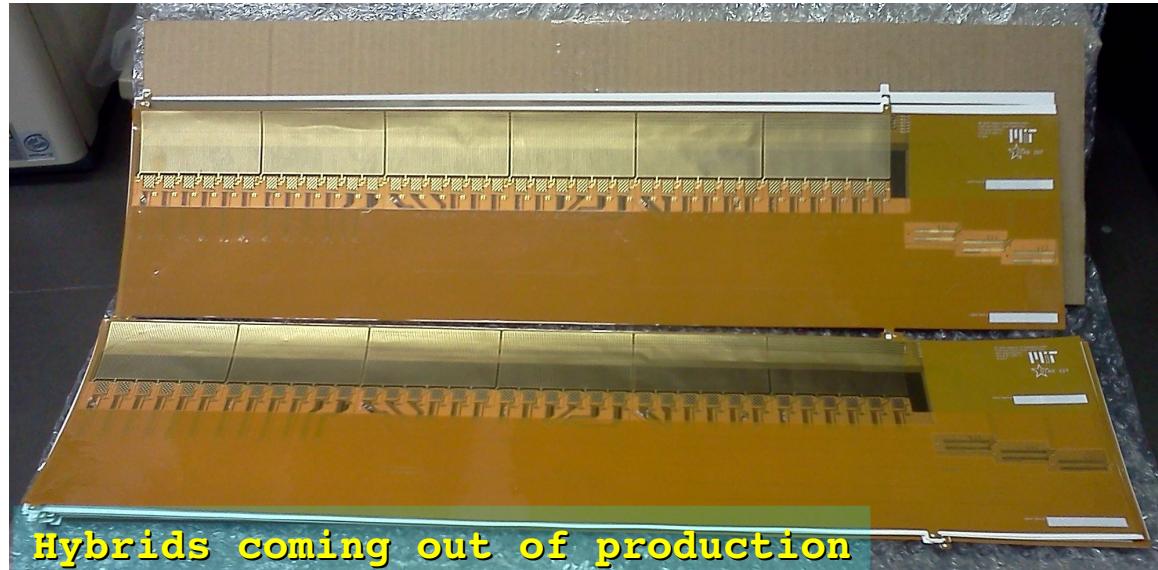
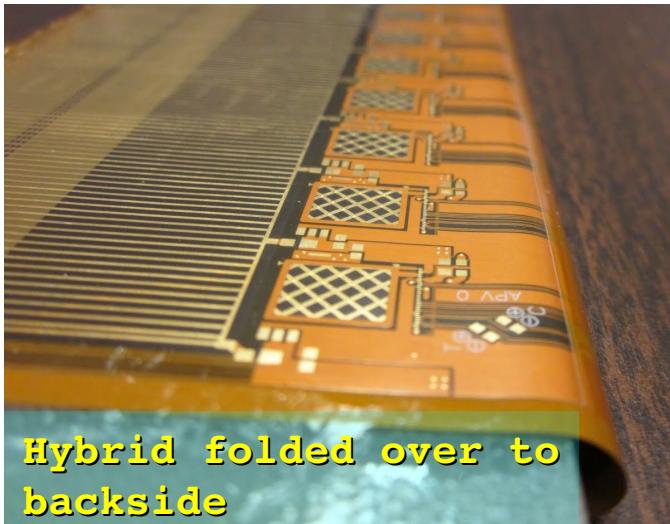


IST stave = carbon fiber ladder + cooling tube
kapton flex hybrid + passive components
+ 6 silicon pad sensors
+ 3 x 12 APV25-S1 readout chips

Electrically divided in 3 units to reduce chance of failure of a full stave

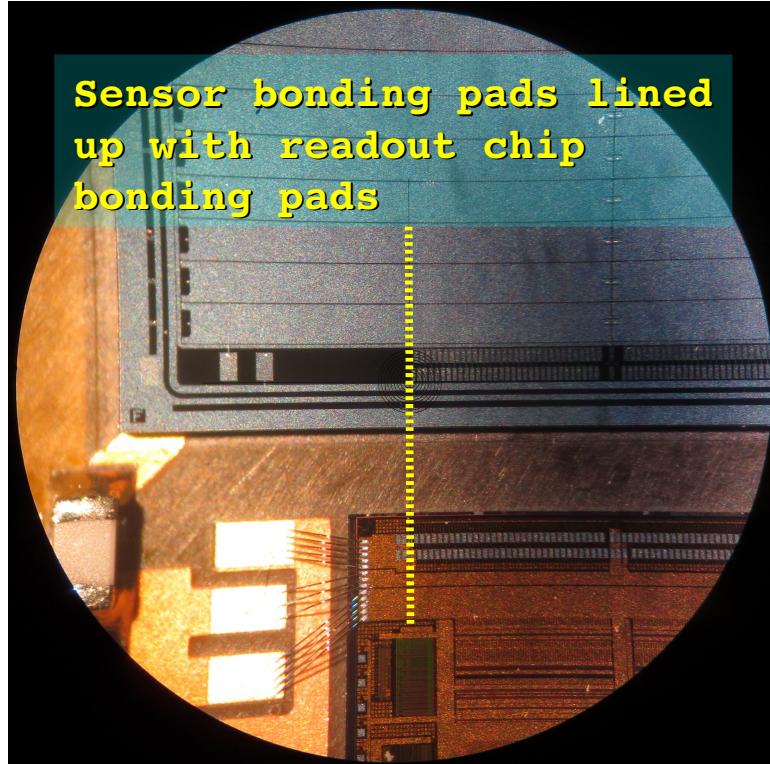
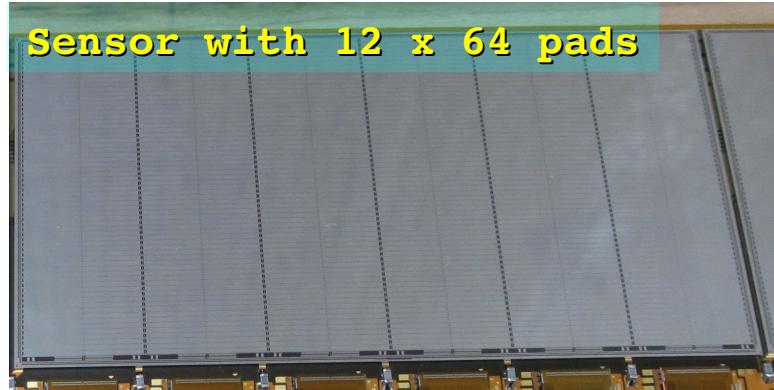
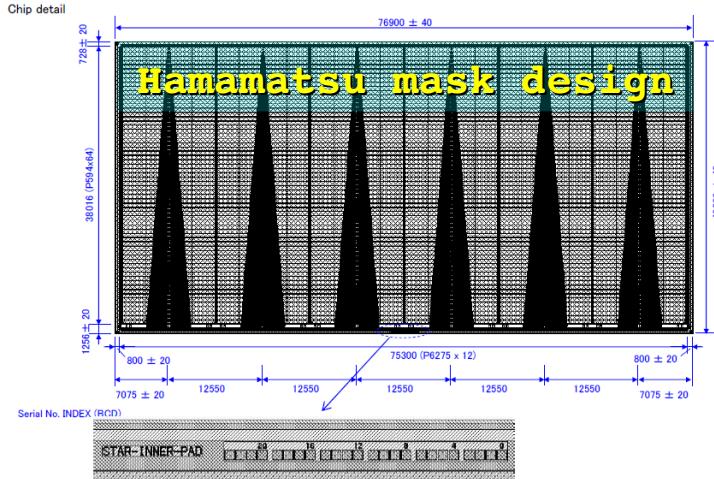
Full prototype stave assembled and tested

IST ladder and hybrid



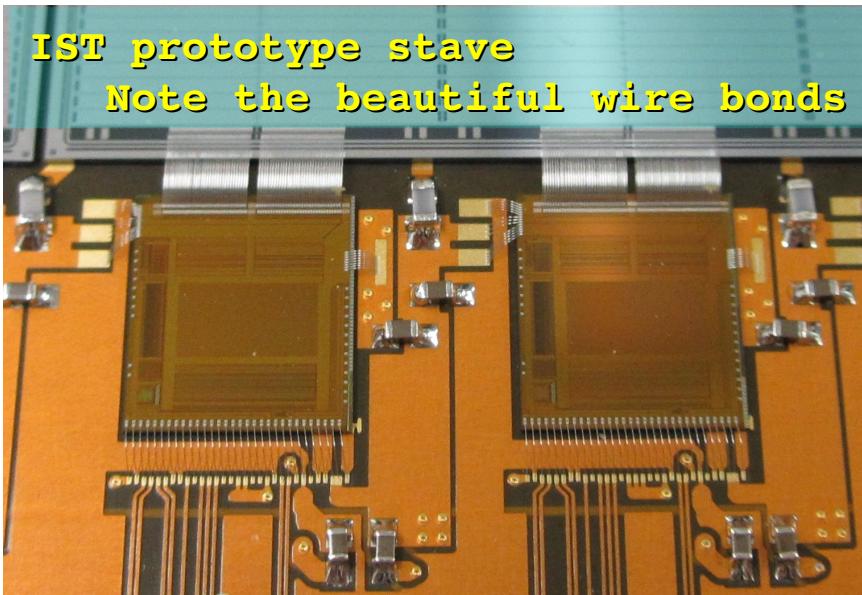
Hybrids in production, to LBNL for lamination with carbon fiber staves, ready in October

IST silicon pad sensor



Silicon sensors being procured, staged production, first batch in October, second in Nov., third in Dec.

IST readout chip



APV25-S1

**Used in STAR by IST, FGT
and GMT**

**Developed for CMS
(75,000 used in tracker)
(used in COMPASS for triple GEM)**

**0.25 um CMOS
Radiation hard**

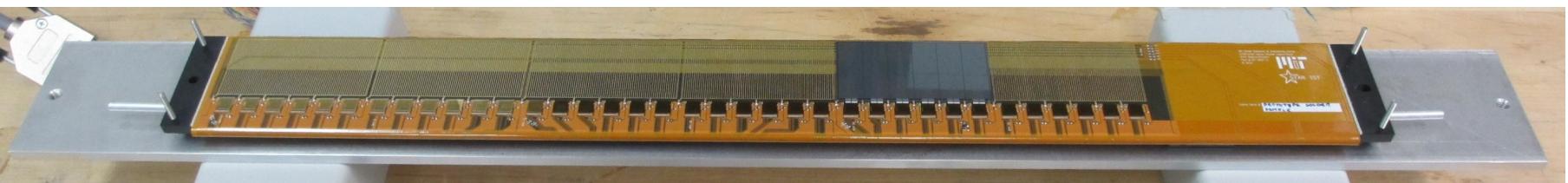
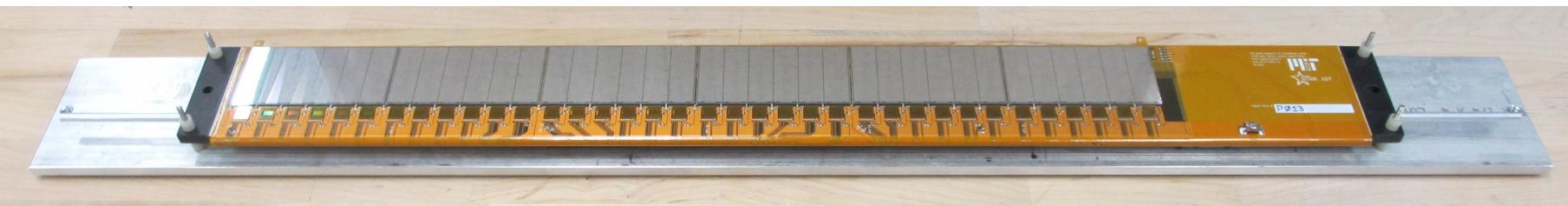
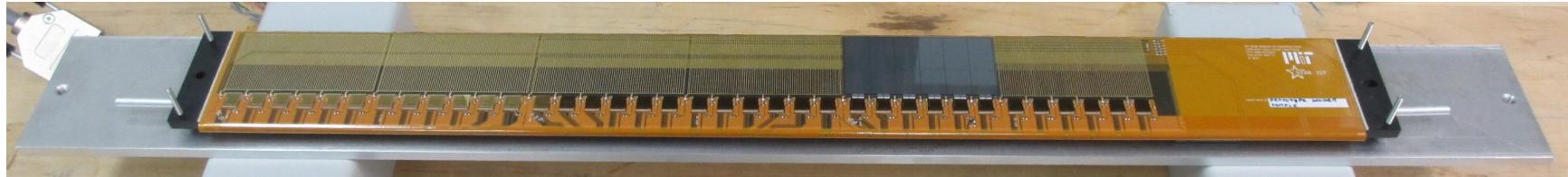
**128 channels parallel sampling
40 MHz sampling rate
4 us analogue pipeline
< 30 us deadtime for 20 MHz
3-sample readout**

> 15:1 signal to noise ratio

0.3 Watt nominal per chip

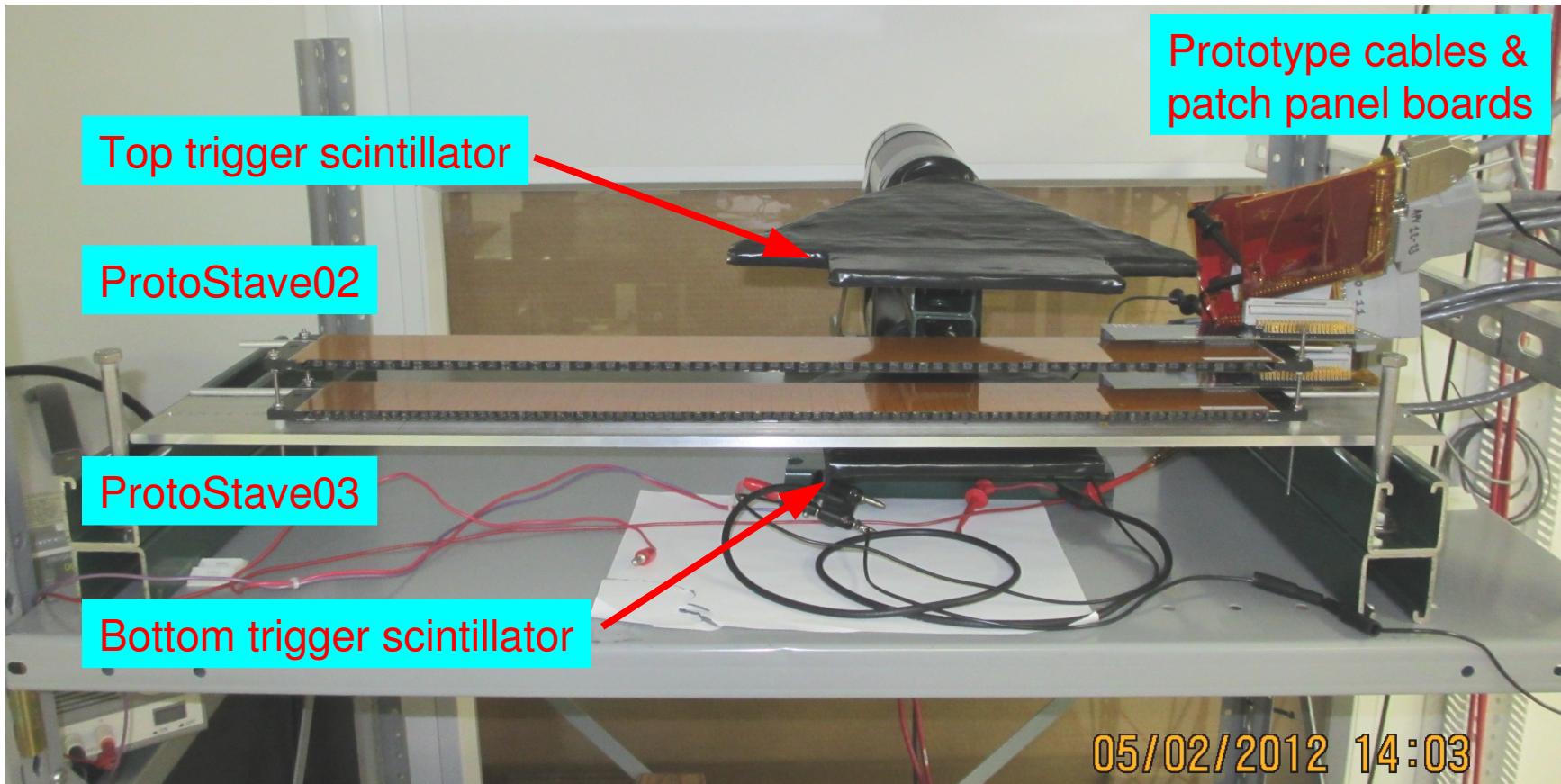
All chips ready for mounting

IST prototype staves



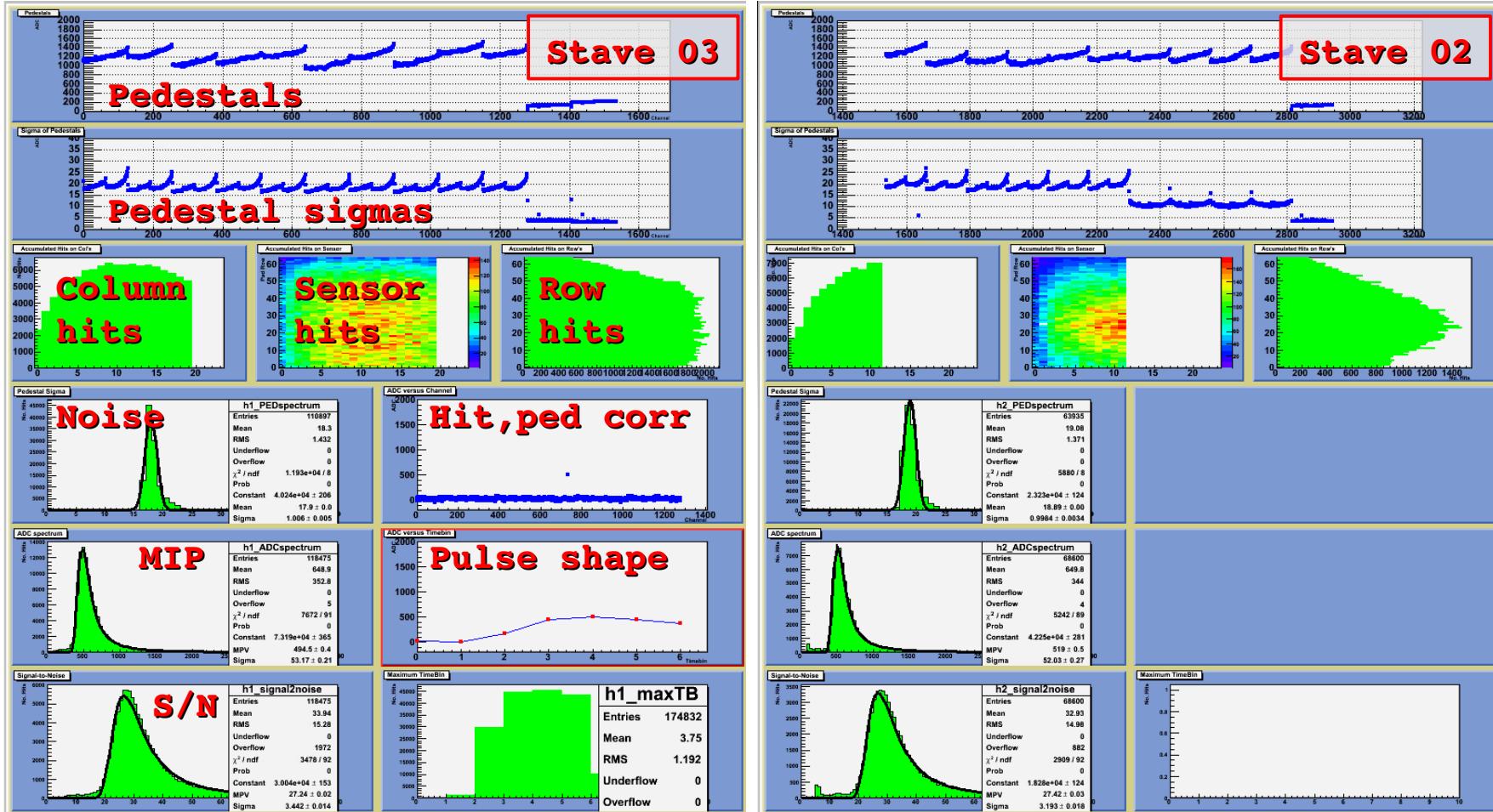
ProtoStave02, 36 APV's, 1 bonded sensor
ProtoStave03, 36 APV's, 6 bonded sensors
ProtoStave04, 12 APV's, 1 bonded sensor

IST Cosmic Ray Setup



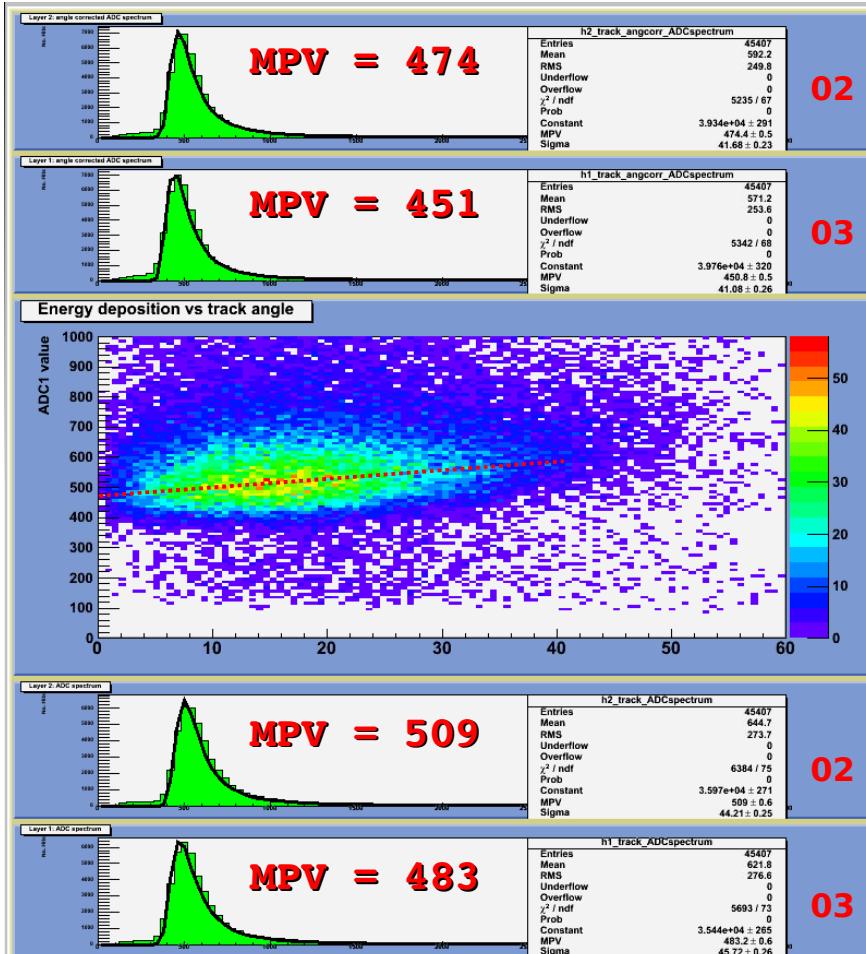
**Basic cosmic data results from 2 staves stack
Tracking with three staves stack ongoing**

IST Cosmic Ray Data I



Everything works as expected, > 99% functional

IST Cosmic Ray Data II



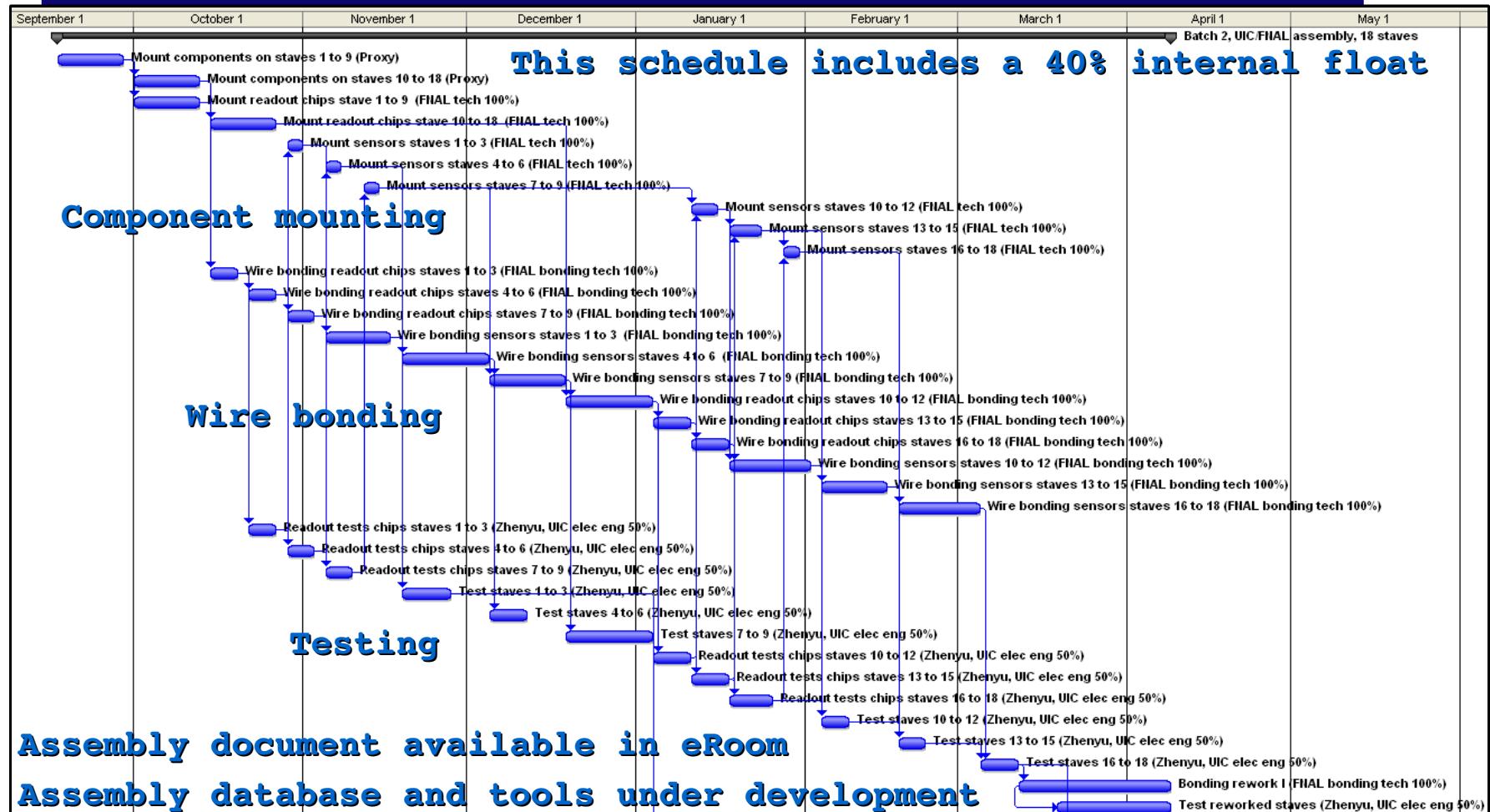
MIP peaks after angle correction

Energy deposition vs Angle Works as expected

MIP peaks before angle correction

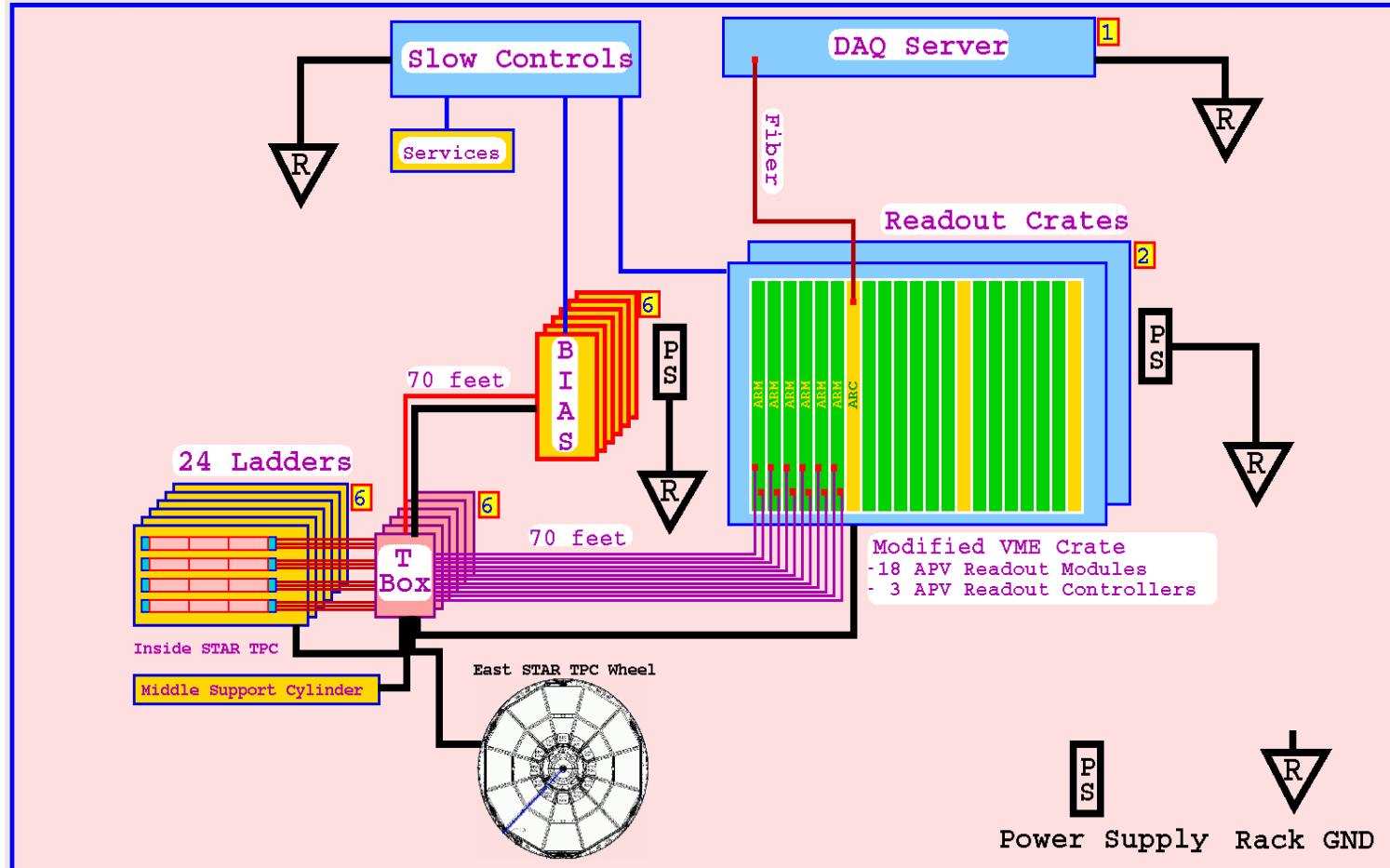
Signal to noise > 20:1, exceeds requirements

IST stave production



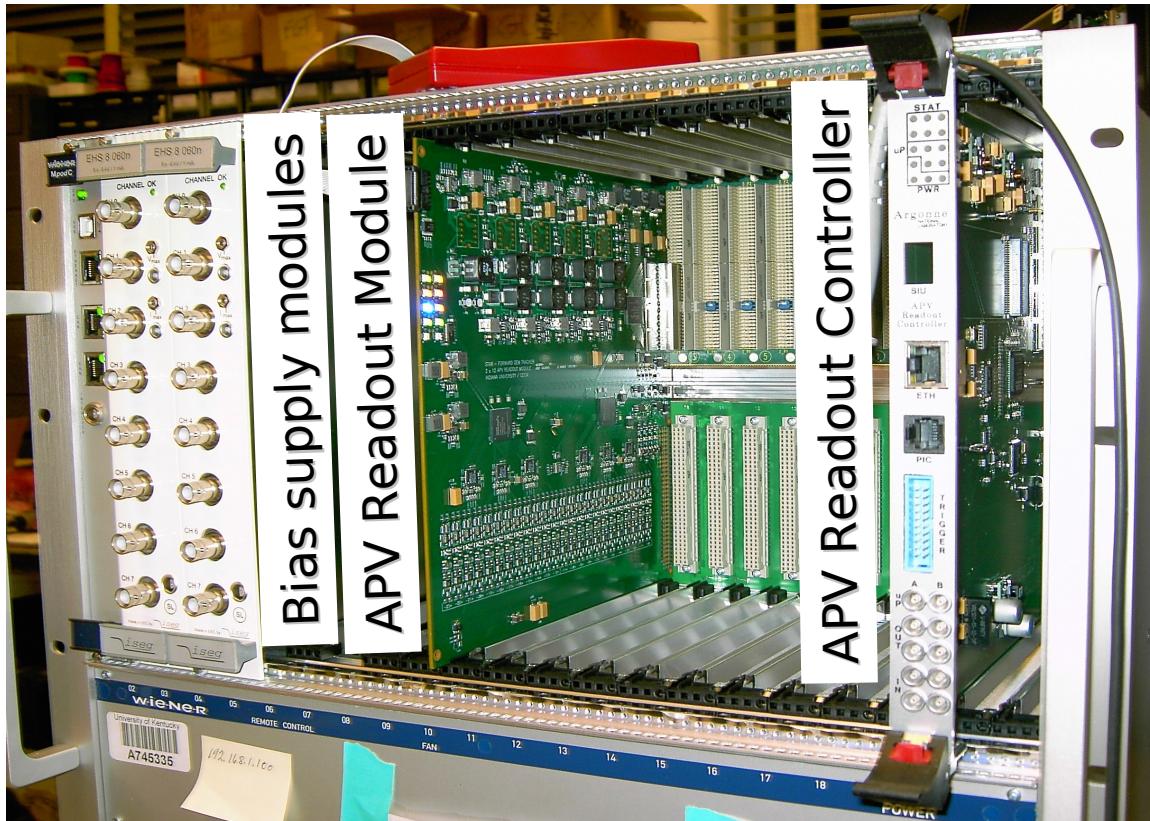
Production at MIT/BNL & UIC/FNAL, ready Mar/Apr

IST readout system



Design 80% done, almost identical to FGT design

IST readout crate



Worked satisfactorily for FGT in RHIC Run 12

First crate procured
First supply procured

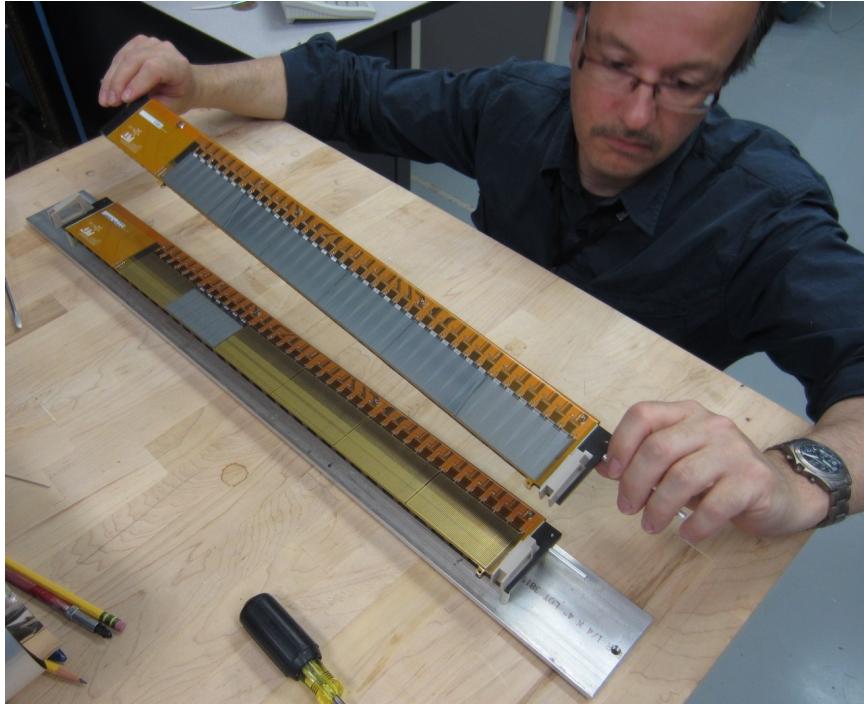
Readout module (ARM)

97% designed

- patch fix
 - backplane fix
 - opt. Signal filter
- Readout controller redesign (ARC-II)
- DRAM buffer
 - patch fixes
 - firmware cleanup
 - fallback is to use ARC-I

ARM and ARC design 90% done, ARM production in Fall, ARC-I or ARC-II ready in Spring 2013

IST stave supports



Assembly done manually



Sufficient clearance between staves

**Individual PEEK pieces support the staves
Supports provide CMM surveyed reference flats
and points for locating staves**

IST milestones

Level	Milestone	BCP #3 Date	Actual /Forecast
1	CD-4 Approve Project Completion	Jul-15	Jul-15
1.3	IST		
2	IST Prototype ladder tested		Apr-12 (A)
2	IST Flex hybrid produced	Jun-12	Jul-12
2	IST First staves produced	Sep-12	Nov-12
2	IST Staves finalized	Mar-13	Mar-13
2	IST assembled onto MSC	May-13	May-13
<hr/>			
3	L3 - Prototype Transition boxes produced and tested	5/17/12	7/12/12 (A)
3	L3 - Sensor procurement finished	7/14/12	12/31/12
3	L3 - Start wire bonding readout chips	7/11/12	10/19/12
3	L3 - Start wire bonding sensors	9/6/12	11/16/12
3	L3 - Stave production finished	10/10/12	11/9/12
3	L3 - Start of layer integration	3/8/13	3/19/13
3	L3 - Readout system procured	2/1/13	2/1/13
3	L3 - Cooling system assembled	10/10/13	10/10/13

Forecast 07/31/12

**Delayed by ~3 months,
mitigation in place
and executed**

End play, still stands

Milestones are being updated, schedule holds

IST human resources



Name	Function	Affiliation	Expertise
Gerrit van Nieuwenhuizen	Physicist	MIT	Sub system manager
Zhenyu Ye	Physicist	UIC	Deputy sub system manager
Yaping Wang	PostDoc	UIC	Stave testing and analysis
Ben Buck	Electronics Engineer	MIT-Bates	Front end electronics, readout
Gerard Visser	Electronics Engineer	IUCF	Readout, DAQ
Anatoly Evdokimov	Electronics Engineer	UIC	Stave testing
Jim Kelsey	Mechanical Engineer	MIT-Bates	Support structure and cooling
Jason Bessuelle	Mechanical Engineer	MIT-Bates	Support structure and cooling
Eric Anderssen	Mechanical Engineer	LBNL	Stave cores and support structure
Peter Binns	Technician	MIT-Bates	Assembly
Bert Gonzalez	Technician	FNAL	Assembly
Bob Soja	Technician	BNL	Stave survey
Don Pinelli	Technician	BNL	Wire Bonding
Tammy Hawke, Michelle Jonas	Technicians	FNAL	Wire Bonding

All players have been identified

IST risk assessment



WBS	Risk description	Mitigation strategy	Level	Risk expiration
1.3.1.3.5	Ladder production delay	scheduling slack	moderate impact low severity	October 2012
1.3.2.2.3	Prototype sensors specification failure	scheduling slack, reliable vendor	moderate impact moderate severity	Retired May, 2012
1.3.2.2.4	Flex hybrid prototype specification failure	scheduling slack, less prototypes	moderate impact moderate severity	Retired May, 2012
1.3.2.3.1	Sensor production problems	reliable vendor, stage batch production	moderate impact low severity	December 2012
1.3.2.3.3	Flex hybrid production problems	scheduling slack by producing early	moderate impact low severity	October 2012
1.3.2.3.6	Readout system problems	FGT design works, desire to upgrade to ARC-II	low impact low severity	March 2012
1.3.3.3	Stave assembly problems	Establish conservative assembly pipeline	moderate impact moderate severity	July 2013
1.3.3.4	Layer integration problems	Scheduling slack, delay installation	moderate impact low severity	August 2013

Part of the full IST risk table



All risks low to moderate, mitigation strategies in place

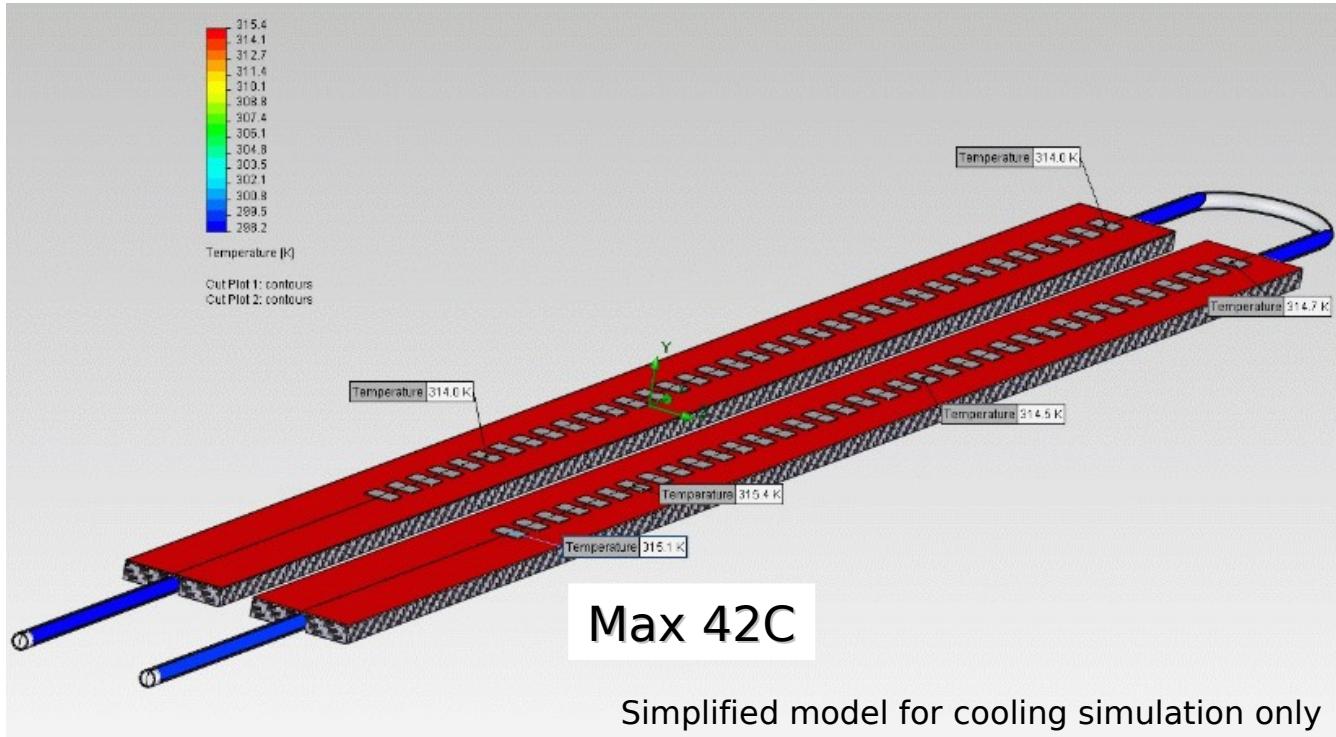
Summary

- Designs for staves 100% complete
- Designs for readout system 90% complete
- Stave prototypes functioned as expected
- Fabrication plan modified to mitigate schedule delays
- Resources are sufficient to satisfy the schedule
- The risk severity is low to moderate for all major subsystem tasks, mitigation strategies are in place or activated already

Backup slides



IST cooling



3M Novec 7200
fluorocarbon cooling
fluid

Inlet 24C
(TPC oper.T)

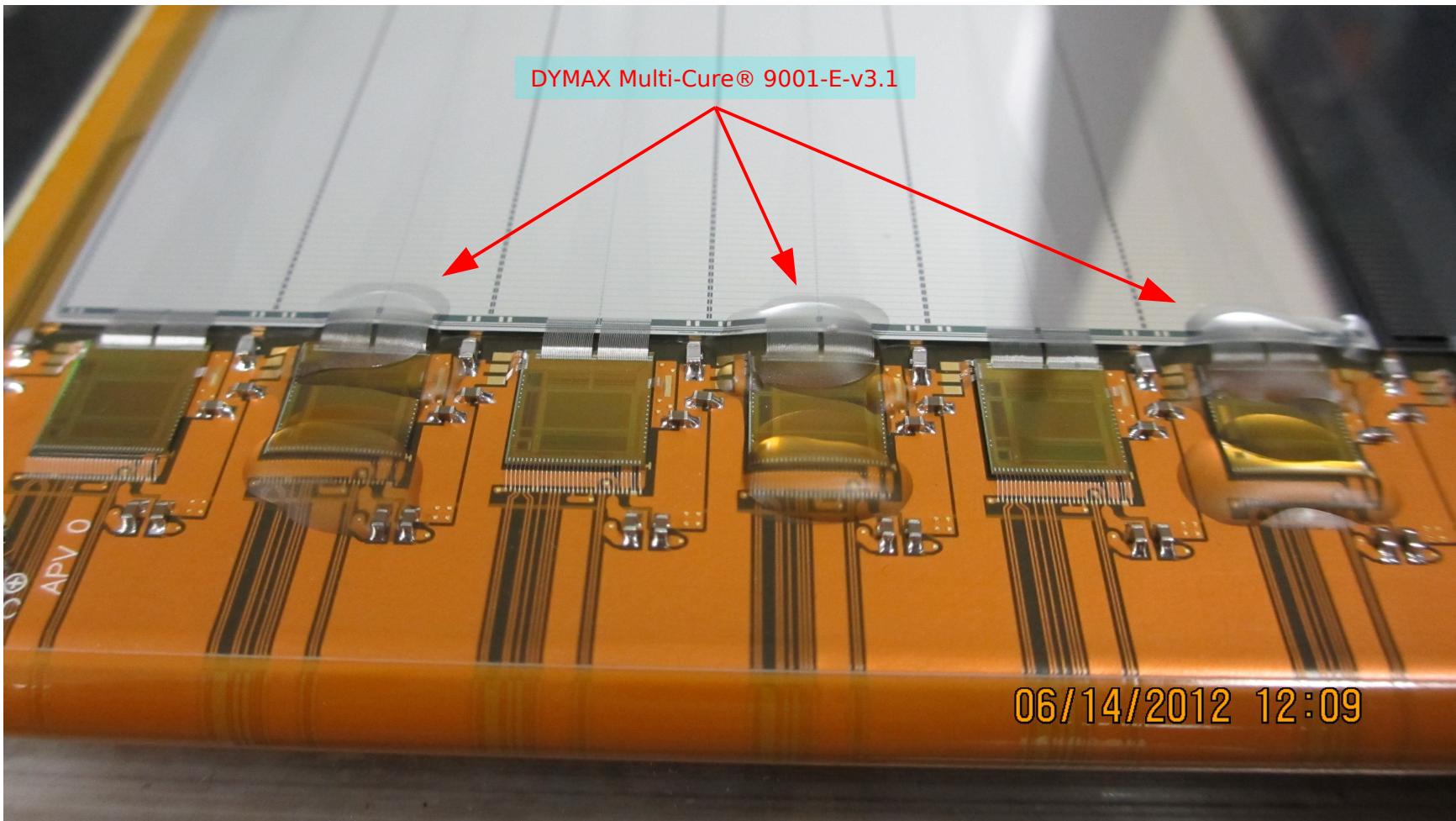
550mW/chip
(1.8 x nominal)

1 liter/min at 20psi

2 staves in series

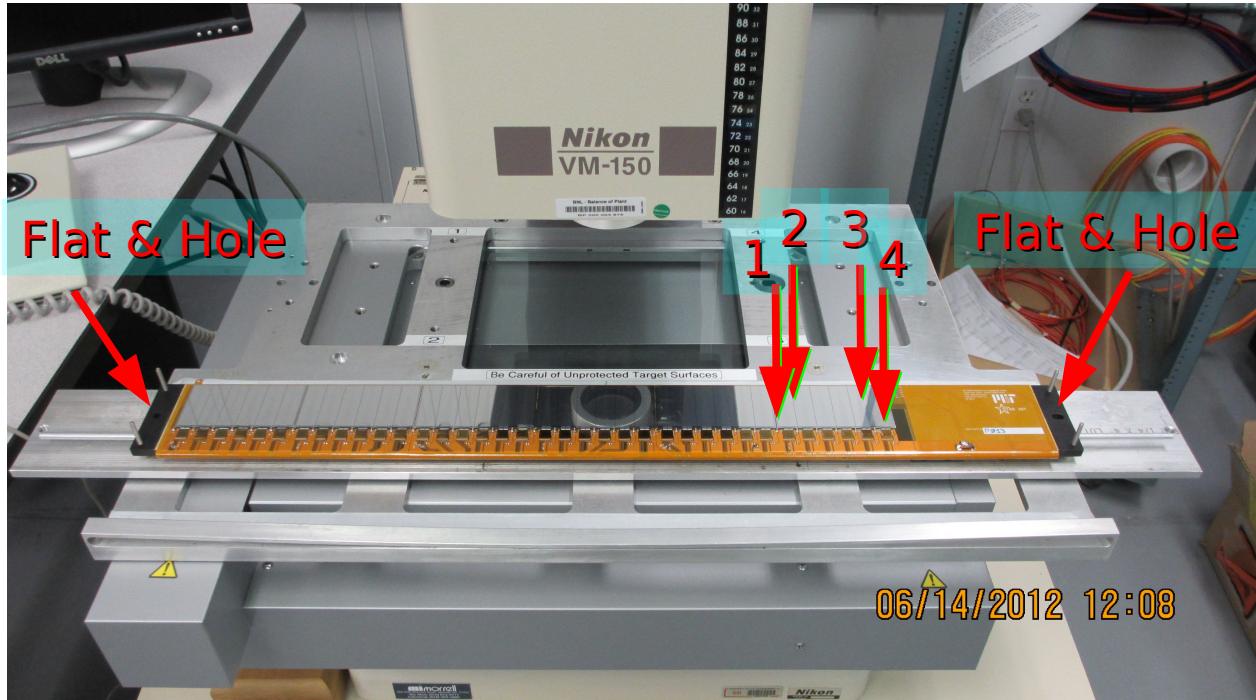
Simulations show 42C max at chips with 1.8x the nominal dissipation and no cooling via's through Kapton hybrid yet
Actual temperature will be lower

IST bonding encapsulation



No performance difference between encapsulation and bare

IST stave survey

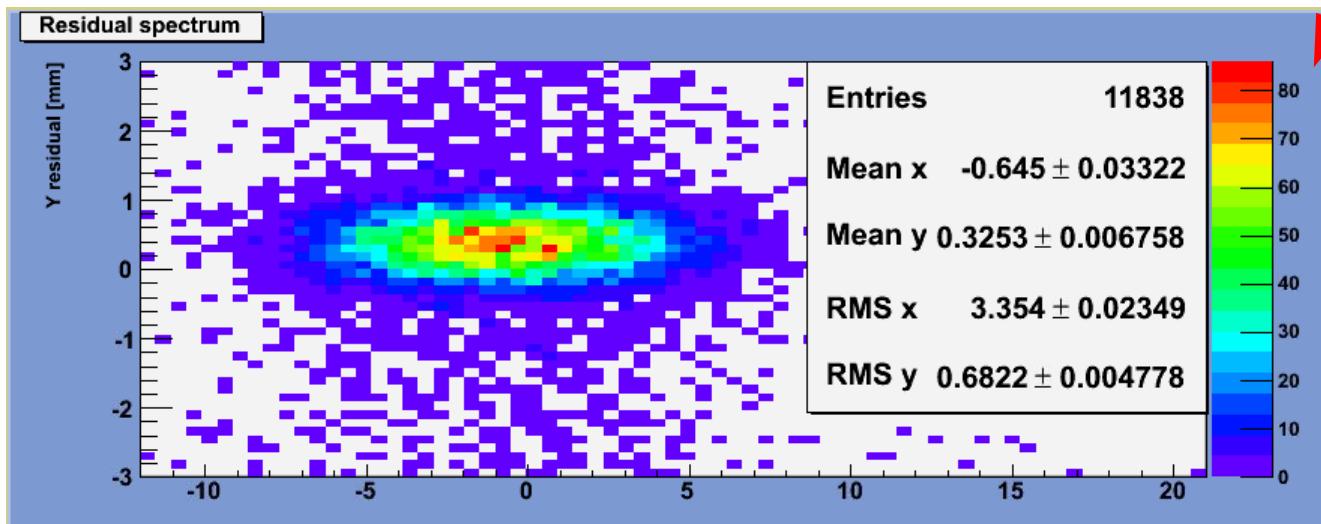
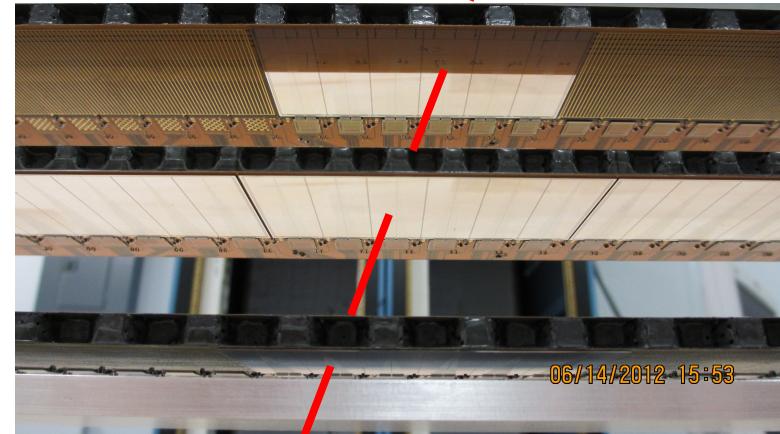


Survey machine operational, needs simple sliding jig. Survey straight forward, technician assigned.

IST 3 layer tracking



3 stave stack for cosmic ray tracking



Tracking residuals are as expected